U. S. FOREST SERVICE

RESEARCH NOTE LS-30

KE STATES FOREST EXPERIMENT STATION • U. S. DEPARTMENT OF AGRICULTURE

# Soil Moisture and Radial Increment in Two Density Levels of Red Pine

As part of an overall study of soil moisture and thinning relationships, individual tree radial increment and soil moisture content were measured in two density levels of red pine at the Cutfoot Experimental Forest near Grand Rapids, Minn. This paper reports on the growth-soil moisture aspects of the study.

Gravimetric soil samples were collected periodically during the 1957 and 1958 growing seasons within 60 and 140 square feet of basal area density levels of 90-year-old red pine. Sampling methods and the soil moisture-thinning relationships are reported in Research Note LS-29.

In general, available soil moisture levels fell during both years throughout the growing season and then rose again during the fall recharge period (fig. 1 shows the soil moisture data for 1957). Slightly more soil water was available under the lower density stand on nearly all sampling dates. However, because of adequate summer precipitation, soil moisture was always plentiful in the 7-foot sampling horizon. This was also true in 1958, a summer when precipitation before and during the growing season was below normal.

A dial gage dendrometer was used to measure the radial increment in 1957 and 1958 on 10 dominant and codominant trees in each of the two density levels (table 1).

After a short period of varying expansion and contraction, continued radial expansion began about May 10 each year in both stands (fig. 2). Monthly growth tended to be slightly better distributed in the 60-square-foot basal

TABLE 1. — *Annual and total radial increment values in two density levels of red pine, 1957 and 1958.*

| Tree number | D.b.h.[1/] | Radial increment 1957 | Radial increment 1958 |
|---|---|---|---|
| | Inches | Inches | Inches |
| DENSITY LEVEL: 140 SQ. FT. BASAL AREA | | | |
| 1 | 11.08 | 0.077 | 0.045 |
| 2 | 9.98 | .050 | .045 |
| 3 | 10.21 | .072 | .038 |
| 4 | 13.33 | .065 | .046 |
| 5 | 13.60 | .076 | .071 |
| 6 | 13.15 | .082 | .072 |
| 7 | 12.10 | .072 | .099 |
| 8 | 13.00 | .096 | .080 |
| 9 | 13.38 | .065 | .086 |
| 10 | 12.24 | .086 | .082 |
| Average | | .074 | .066 |
| DENSITY LEVEL: 60 SQ. FT. BASAL AREA | | | |
| 11 | 14.25 | .133 | .130 |
| 12 | 13.50 | .089 | .135 |
| 13 | 13.00 | .161 | .144 |
| 14 | 14.10 | .112 | .162 |
| 15 | 12.80 | .107 | .147 |
| 16 | 13.62 | .092 | .099 |
| 17 | 13.96 | .092 | .115 |
| 18 | 12.86 | .073 | .078 |
| 19 | 13.75 | .166 | .189 |
| 20 | 14.29 | .125 | .119 |
| Average | | .115 | .132 |

[1] *D.b.h. at time dendrometer station was established.*

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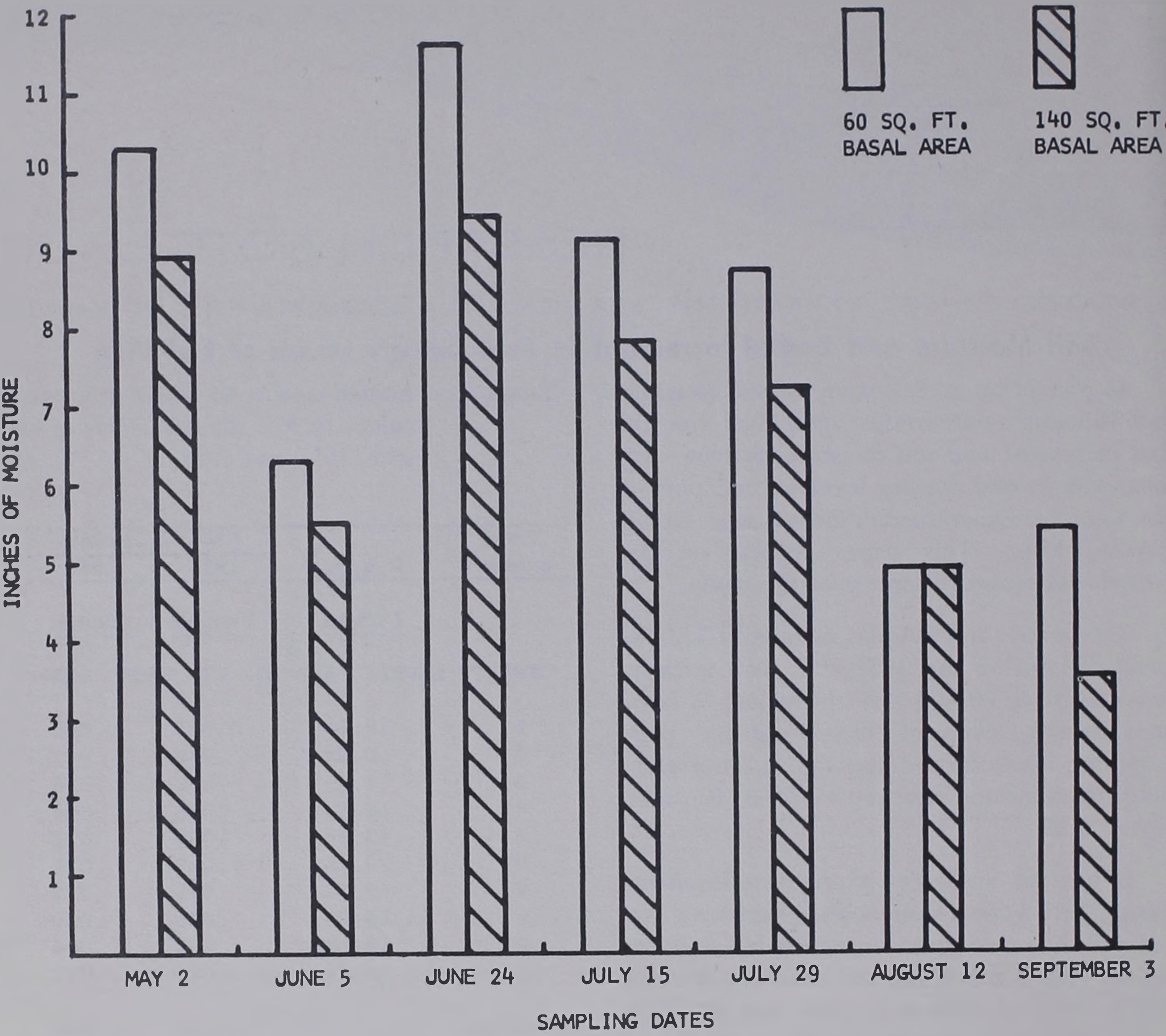


FIGURE 1. — Available soil moisture in the 0-7 foot profile under two density levels of red pine, 1957.

area block (table 2). However, in each stand during both years the greatest monthly radial growth occurred during June.

Growth ceased in both stands during early September each year even though the low-density level contained about 2 inches more soil moisture than the high-density level. Thus, the end of radial growth was not dependent upon soil moisture in the years of this study. This has been noted by others.[1]

In addition, midsummer soil moisture levels did not drop low enough to influence growth seriously in either stand because of frequent rains during the study period. Other studies in areas where summer droughts are common have shown close relationships between soil moisture depletion and growth patterns.[2] However, other factors, such as light, temperature, genetic qualities, and the previous season's growth also contribute to each year's growth behavior.

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[1] *Dils, Robert E., and Day, Maurice W. The effect of precipitation and temperature upon radial growth of red pine. The Amer. Midland Naturalist 48: 730-734, 1954.*

[2] *Boggess, W. R. Weekly diameter growth of short-leaf pine and white oak as related to soil moisture. Soc. Amer. Foresters Proc. 1956: 83-89. 1956.*

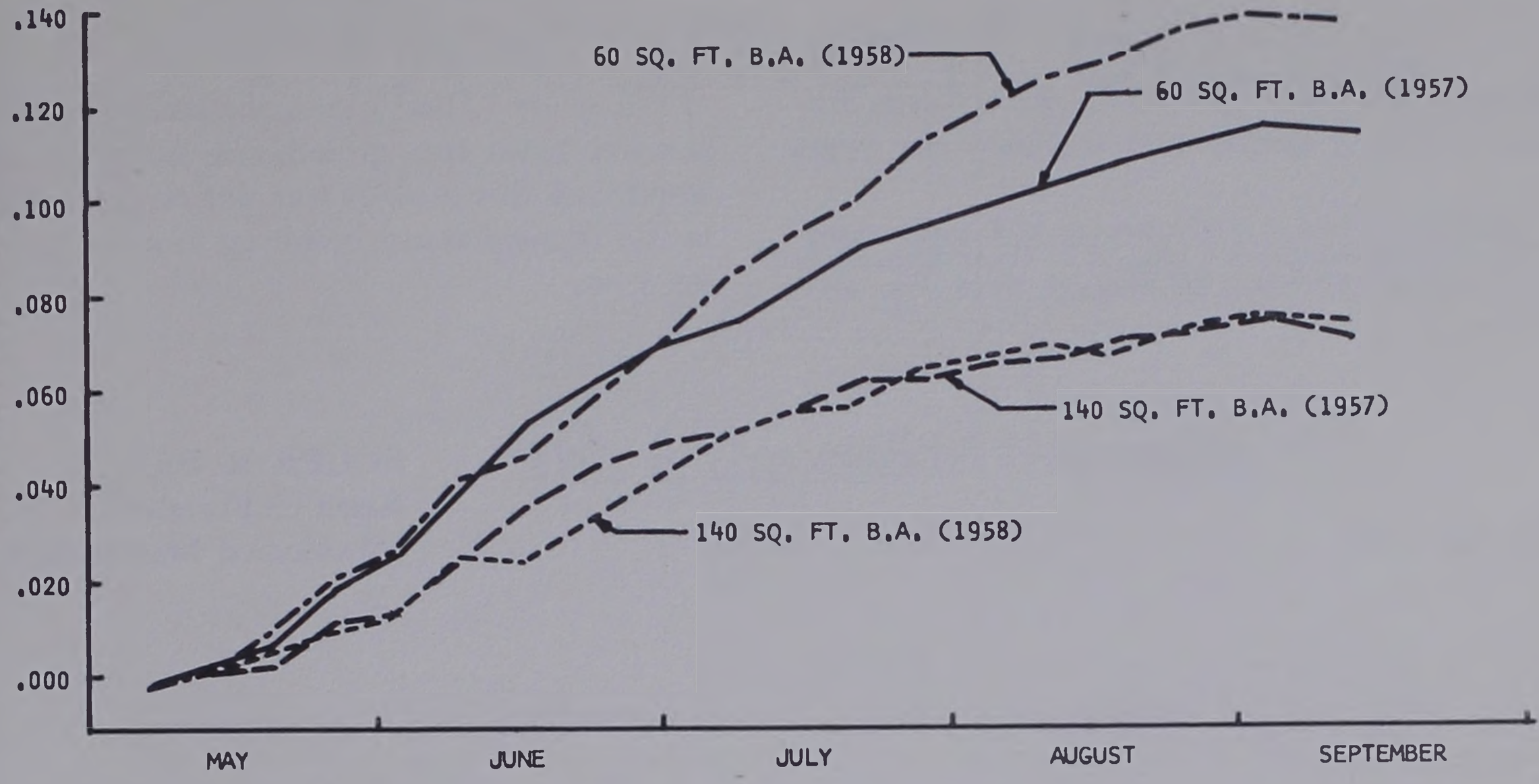


FIGURE 2. — Radial increment patterns in two density levels of red pine, 1957 and 1958.

TABLE 2. — *Monthly radial increment as a percent of total growth in red pine between May 1 and September 1*

| Month | 60 sq. ft. basal area | | 140 sq. ft. basal area | |
|---|---|---|---|---|
| | 1957 | 1958 | 1957 | 1958 |
| May | 21.1 | 18.7 | 17.8 | 16.2 |
| June | 33.3 | 33.1 | 42.5 | 40.5 |
| July | 29.8 | 31.7 | 26.0 | 31.1 |
| August | 15.8 | 16.5 | 13.7 | 12.2 |

An interesting sidelight of this study dealt with overwinter shrinkage of the tree bole and daily fluctuation in dendrometer measurements. Overwinter radial measurements reached a minimum in late March or early April. The greatest radial shrinkage was 0.022 inch and the average was approximately 0.015 inch, or about 20 percent of the previous year's growth, in the 140-square-foot level. Early spring bole swelling recaptured most of this shrinkage before sustained radial growth began. Dendrometer measurements were also taken three times a day for a short time to obtain an idea of tree-size fluctuations in a day. The measurements indicated that shrinkage of the bole took place during some days, but the trees regained or exceeded their former size overnight. These data point out the need for standardizing the time of measurement in this type of study.

The most important relationship indicated is the large increase in diameter growth in the thinned stand, compared to the much smaller diameter growth in the denser stand. Average basal area growth on the individual trees in the lighter stocking level was 1¾ times the growth in the denser stand in 1957 and over twice as much in 1958. There was little difference in

per-acre basal area growth for these stands during a 10-year period that included the years of this study.[3] Thus, nearly the same amount of per-acre basal area growth was added to each stand, but this growth was put on fewer trees in the thinned stand, resulting in more growth per tree.

[3] *Buckman, Robert E. Three growing stock density experiments in Minnesota red pine. U.S. Forest Serv., Lake States Forest Expt. Sta., Sta. Paper 99, 10 pp., illus. 1962.*

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